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HELIPORT PARKING TAXIING AND LANDING AREA CRITERIA TEST 1/1  
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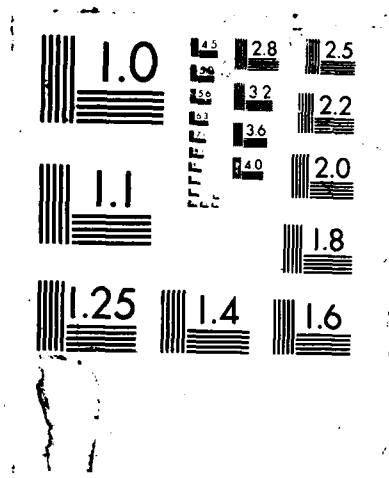
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## Heliport Parking, Taxiing, and Landing Area Criteria Test Plan

Rosanne M. Weiss

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July 1987

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# Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN87/10		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle  HELIPORT PARKING, TAXIING, AND LANDING AREA CRITERIA TEST PLAN				5. Report Date July 1987	
				6. Performing Organization Code ACT-140	
				8. Performing Organization Report No.  DOT/FAA/CT-TN87/10	
7. Author(s) Rosanne M. Weiss				10. Work Unit No. (TRAIS)	
9. Performing Organization Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Center Atlantic City International Airport, N.J. 08405				11. Contract or Grant No. T0701R	
				13. Type of Report and Period Covered  Technical Note July 1987	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Program Engineering and Maintenance Service Washington, D.C. 20590				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract <p>This flight test plan describes the methodology to examine and validate the current heliport surface separation and maneuvering criteria as defined in the Heliport Design Guide and determine if changes can be made to the current criteria. Operational measures will be collected at the Indianapolis Heliport, Indiana, and Wall Street Heliport, New York. Additional flight tests will be conducted at the Federal Aviation Administration (FAA) Technical Center, Atlantic City International Airport, New Jersey, using instrumented UH-1H and S-76 helicopters.</p> <p>Flight maneuvers at the Technical Center are to identify vertical variation from the recommended taxiing heights and lateral variation from a predetermined path, under various wind and lighting conditions. Wind velocity and barometric pressure data will be collected during hover operations to determine rotorwash effects at different locations around a helipad, taxiway, and parking areas. This data will be used to create a baseline to be used in characterizing heliport surface maneuver areas. The test development, test equipment, data collection, and data reduction and analysis of the flight data are discussed. A schedule for the completion of the associated tasks is presented.</p>					
17. Key Words  Surface Maneuver                      Heliport Peripheral Area                      Helicopter Parking Areas/Heliport              Taxiways Separation Criteria Heliport Parking				18. Distribution Statement  This document is available to the U.S. public through the National Technical Information Service, Springfield, 22161	
19. Security Classif. (of this report)  Unclassified		20. Security Classif. (of this page)  Unclassified		21. No. of Pages 20	
				22. Price	

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## EXECUTIVE SUMMARY

The Guidance and Airborne Systems Branch, ACT-140, received a request from the Office of Airport Standards, AAS-100, to examine and validate the current heliport surface separation and maneuvering criteria as defined in the Heliport Design Guide and determine if changes can or should be made to the current criteria.

Several factors prompted this activity. The current criteria was based on experience tempered with engineering judgement and industry has challenged this criteria as being too conservative. Little data exist which validate the current criteria. With the rapid growth in the helicopter industry and in public acceptance of the helicopter as a mode of transportation, heliport construction, many at confined locations, has increased.

The primary objectives of this program are to collect unobtrusive operational measures (induced wind velocity changes and pressure changes) at active public use heliports at 18 inches above the surface. The vertical rotor induced wind velocity and pressure change profiles will be defined under certain environmental conditions to assure correspondence to the operational data.

Another aspect of this project will be to determine lateral and vertical position during taxiing maneuvers flown by subject pilots under various lighting and wind conditions. These maneuvers will be tracked using a laser ground-based tracking system. The data will be merged with aircraft data consisting of recorded performance factors and analyzed to yield statistics concerning lateral deviation from a predetermined path and vertical deviation from recommended taxiing heights.

Both measures (induced wind and pressure changes and crosstrack deviation and vertical track deviation) will be used to verify the current Heliport Design Guide's separation criteria for parking areas, taxi operations, and for the landing/takeoff areas.



## 1. INTRODUCTION.

### 1.1 PURPOSE.

This test plan describes Part II of the Helicopter Visual Meteorological Conditions (VMC) Clearance project and has the following purpose:

- a. Identify problems for investigation and define tasks for their resolution.
- b. Develop appropriate test procedures.
- c. Specify required data.
- d. Describe methods for data collection, reduction, and analysis.

### 1.2 BACKGROUND.

The focus of this test is on the issue of criteria for separation in ground maneuver areas at a heliport and includes separation between aircraft and/or between aircraft and obstructions.

The criteria for separation in ground maneuver areas, as stated in the Federal Aviation Administration (FAA) Heliport Design Guide, has been challenged by industry as being overly conservative. The data collected during this test activity will examine rotorwash due to aircraft maneuvers in these areas and determine helicopter movement performance during ground taxiing and hovering operations to determine whether changes to the criteria can be supported. The FAA Heliport Design Guide states:

"The primary surface is a horizontal plane, at the elevation of the heliport, defining the area of ground, water, or structure used by helicopters while taking off or landing. A separate primary surface shall be designated for each intended direction of operation. The primary surface shall have a width of at least two rotor diameters. It shall have a length of at least two rotor diameters when the heliport serves single rotor helicopters exclusively, or the overall length plus one rotor diameters when the heliport serves both single and tandem rotor helicopters. The primary surface should be of sufficient length to allow helicopters to attain takeoff speed."

"Helicopter parking areas sufficient to meet the needs of based and transient users should be provided. Parking positions shall be located so that no portion of a parked helicopter will penetrate the airspace surfaces of an adjoining takeoff and landing position or taxi route. Helipads may be provided in lieu of paving the entire parking area (apron). Pads shall be at least twice the wheel base or tread width, or skid length or width, of the largest using helicopter. To facilitate loading or unloading of passengers or baggage, or for fueling or maintenance services, larger pads or an apron may be needed."

And, "If helicopter parking positions are outside of the primary surface a taxi route or taxiway shall be provided between the takeoff and landing positions and parking position. A cleared right-of-way shall be provided for helicopter taxi routes. The width of a taxi route shall be at least twice the rotor diameter of

the largest helicopter expected to use the route. To minimize the downwash effect on persons and property along the taxi route, an additional one-half rotor diameter, but not less than 20 feet (6m), should be maintained clear of people and loose objects. If a hard surface taxiway is provided it shall be centered within a taxi route. The width of a paved taxiway shall be at least twice the tread width of the widest wheel equipped helicopter expected to use the taxiway."

Figure 1 pictorially depicts these areas.

### 1.3 OBJECTIVES.

The objectives of this project are as follows:

- a. To obtain unobtrusive operational measures of the heliport environment. This includes wind speed, direction, and barometric pressure readings.
- b. To define vertical profiles of wind velocity distributions under certain environmental conditions, assuring correspondence to the field.
- c. Determine the variations in aircraft's lateral and vertical position during surface maneuvers under various wind and lighting conditions.
- d. Verify the current Heliport Design Guide's separation criteria for parking areas, taxi operations, and for the primary zone.

### 1.4 TEST LOCATION.

The majority of the maneuvering tests will be conducted at the FAA Technical Center, Atlantic City International Airport, New Jersey. Hover operations will be conducted at the Center's new Demonstration and Concepts Development Heliport. The taxi operations will be conducted on taxiway Alpha, off of runway 22. The flight test aircraft will generally remain within one rotor radius  $\pm 5$  ft. of the heliport surface. The aircraft tracking system, data recording system, and data reduction equipment are located at the Center.

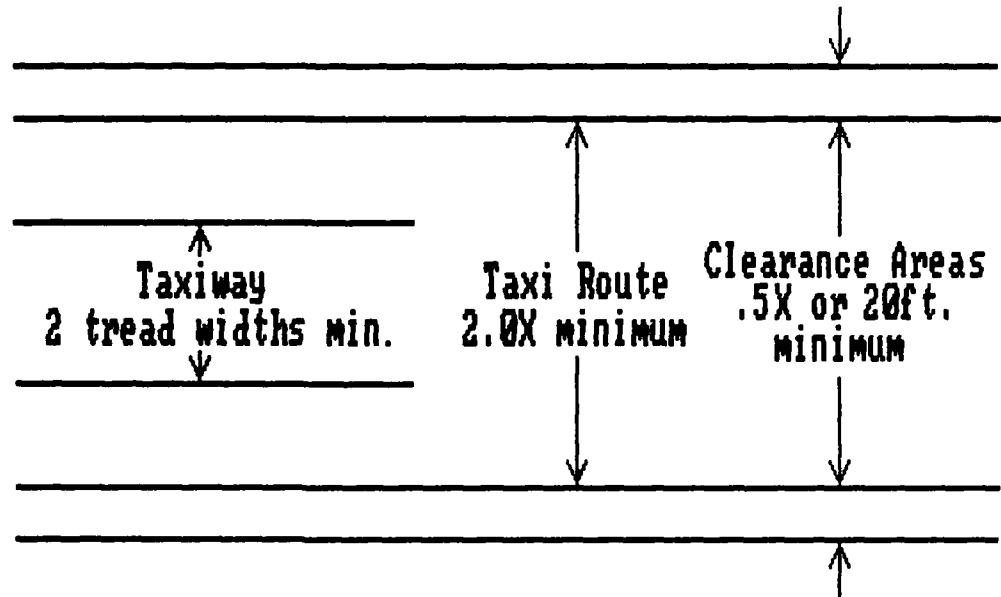
Maneuvering and hovering data will also be obtained at other operational heliports such as Battery Park in New York, New Orleans, and/or Indianapolis. For these locations rotorwash measures (wind and barometric pressure information) will be obtained at a height of 18 inches above ground level (AGL) in the presence of helicopter maneuver operations.

## 2. PROBLEM/TASKS.

### 2.1 STATEMENT OF THE PROBLEM.

The current FAA separation criteria at heliports is based on experience tempered with engineering judgement. The Heliport Design Guide defines the primary surface which includes a safety area around the takeoff and landing area, as having a width of at least two rotor diameters and a length of two rotor diameters when the heliport serves only single rotor helicopters exclusively or the overall length plus one rotor diameter when the heliport serves both single and tandem rotor aircraft. The lateral clearance between any buildings or objects must be at least 20 feet along a taxi route. Little actual data for

Landing/Takeoff Area  
 2.0X minimum  
 Length and Width

X = Rotor Diameter of the  
 largest Helicopter  
 which will use the pad

Parking Area - Twice the wheel base  
 or tread width of the  
 largest using helicopter.

FIGURE 1. SEPARATION/SAFETY AREAS

determining the effects of the rotorwash generated by maneuvering aircraft at operational heliports has been collected. Thus, these criteria have not been validated (see figure 1).

## 2.2 TASKS.

### 2.2.1 Effects of Rotorwash on Surface Winds and Barometric Pressure.

Unobtrusive measures will be collected at the Indianapolis and Battery Park Heliports. This data will be collected at 18 inches above the surface so as not to pose a hazard to the maneuvering aircraft. The sensor height was selected so that the pilots would hover as they would normally. Up to ten anemometers will be placed at various locations around the landing/takeoff pad. The aircraft will hover at a maximum of 10 feet above the surface and measures of wind speed and direction will be recorded. The heliport operational environment in terms of rotor induced changes in wind speed and direction will be analyzed to determine the horizontal and vertical movement of the rotorwash.

In addition, five barometric pressure sensors will be placed strategically around the pad to determine the operational environment in terms of changes in barometric pressure due to the rotorwash. Tests at the Technical Center will be similar with the exception that the maneuvers will be reflowed with the sensors at 18 inch, 3 foot, 10 foot, and 25 foot heights. Using existing analytical models, the results of this test will be used to predict a helicopter's rotor downwash characteristics based on the measures obtained at 18 inches.

### 2.2.2 Helicopter Performance at the Surface.

At the Technical Center the aircraft will be tracked to determine variations from a predetermined taxiing path and from desired taxi height limits, lateral and vertical position, during the maneuvering/taxiing operations. The data collected will be reduced and analyzed to determine maneuvering/taxiing performance limits during movement to/from the takeoff and landing area and the parking/service area, as well as performance limits while the aircraft is hovering at the pad or parking/service areas.

## 3. FACILITIES AND INSTRUMENTATION.

### 3.1 TEST AIRCRAFT.

A Bell UH-1H and an S-76 will be used at the Technical Center for the maneuvering tests.

#### 3.1.1 Bell UH-1H.

The UH-1H, the military version of the Bell 205, is a single turbine engine, single rotor helicopter designed to carry up to 14 passengers and a pilot. It is capable of speeds up to 120 knots and its main rotor is 48 feet in diameter. The UH-1H has a maximum takeoff weight is 9,500 pounds. The use of this aircraft has been obtained through an Inter-Agency agreement with the Department of the Army.

### 3.1.2 Sikorsky S-76

The S-76 is a twin turbine engine, single main rotor helicopter designed to carry up to 13 passengers and a pilot. It is capable of speeds up to 155 knots, has a maximum takeoff weight of 10,300 pounds, with a main rotor diameter of 44 feet.

### 3.2 GROUND TRACKING.

The GTE Sylvania Laser Optical Tracking System will be the only tracking system utilized for the maneuvering tests conducted at the Technical Center.

The laser is the primary precision source for aircraft position data. It has a maximum reliable range of 7 miles, with an accuracy of 2 feet in clear visual conditions, and can track an aircraft from takeoff through touchdown.

### 3.3 AIRBORNE DATA COLLECTION EQUIPMENT.

The airborne data collection system on the UH-1H is a Motorola 6809 microprocessor-based package which is a combination of an off-the-shelf data package and FAA designed and built interface boards. The system is capable of recording the parameters listed in table 1 for storage on a Kennedy magnetic tape recorder.

### 3.4 WIND SENSOR EQUIPMENT.

The anemometers to be used to collect wind data during the aircraft maneuvers are Belfort Instrument Company 5-122 HD Wind Vector Transmitters. These transmitters consist of two major elements: an upper section containing a wind speed generator attached to an airplane rudder shaped vane, and a fixed, vertical support and connector housing. The wind speed signal generator is housed in a weatherproof housing and is driven by a six-bladed propeller. The transmitter senses both wind speed and direction. It then converts these measurements into two direct current (dc) voltages, one which is proportional to both wind speed and the sine of the wind angle, and the other which is proportional to wind speed and the cosine of the wind angle. These signals will be processed and stored on a personal computer (PC) for analysis.

## 4. TESTING AND DATA COLLECTION.

### 4.1 SUBJECT PILOT SELECTION.

Five UH-1H pilots from the Technical Center will be asked to maneuver the helicopter at the Technical Center's Concept Development Heliport. Other pilots can be recruited if necessary from the Avionic Research and Experimental Activities Center, Ft. Monmouth, N.J., and local corporate flight departments. S-76 pilots will come from the Technical Center as well as from private industry. A diverse range of experience is desired so the conclusions will be based on average helicopter piloting skills.

Subject Pilots at the operational heliports will be solicited on an "as available" basis.

TABLE 1. UH-1H AIRBORNE DATA COLLECTION PARAMETERS

<u>Parameters</u>	<u>Units</u>	<u>Minimum Sample Rate/Second</u>	<u>Significance Level</u>
Time	Hours/minutes/seconds	-	0.001 sec
Indicated airspeed	Knots	2	0.0977 kt
Vertical velocity	Feet/minute	2	0.488 ft/min
Aircraft heading	Degrees	2	0.022 deg
Barometric altitude	Feet	2	1.95 ft
Radar altitude	Feet	2	1.732 ft
MLS azimuth deviation	Microamps	2	0.02 $\mu$ A
MLS elevation deviation	Microamps	2	0.02 $\mu$ A
MLS azimuth	Degrees	2	0.005 deg
MLS elevation	Degrees	2	0.005 deg
MLS range (DME/P)	Feet	2	3 ft
All digital MLS flags	-	2	-
All cross pointer flags	-	2	-
Transverse acceleration	g's	2	0.0012 g's
Longitudinal	g's	2	0.0012 g's
Vertical acceleration	g's	2	0.0049 g's
Time code generator time	Milliseconds	-	0.001 ms

#### 4.2 DATA COLLECTION MANEUVERS.

Hovers will be carried out at the center of the helipad and will be for a duration of 5 minutes. After the initial 5-minute hover, the aircraft will be maneuvered from the hover point to the starting point for the taxiing operations.

For the taxiing operations testing, each subject pilot will maneuver the aircraft along a predetermined path of 300 feet in length, at a height of at least 3 feet, but no higher than 10 feet AGL. Maneuvers along the predetermined path will be carried out a minimum of five times by each pilot. This reference path will be identified to conform with markings found in the field, i.e., no centerline, edge markings, and no markings.

The actual path flown during the maneuver will be tracked, which will allow for measurement of pilot performance while the aircraft is in ground effect.

Wind speed and direction and barometric pressure will be recorded during the hover and during the maneuver to the taxiing operations start point.

#### 4.3 DATA RECORDING AND COLLECTION.

Data will be collected to determine the precision with which the pilots are able to control the position and flightpath of the helicopter relative to the intended path during the taxi/maneuver operations. This requires:

- a. An accurate determination of the helicopter position relative to the taxiway.
- b. Measurement of pilot performance.
- c. Knowledge of the intended path during the taxi/maneuver operation.

These measures and aircraft positions will be determined from the following sources:

- a. Ground-based position tracking system.
- b. Airborne data collection system.
- c. Observer log/comments (see appendix A).

##### 4.3.1 Preflight Briefing.

During the preflight briefing the subject pilot will be presented with an overview of the objectives of the maneuver test and an outline of the paths to be flown.

##### 4.3.2 Tracking.

Tracking of the taxiing maneuvers will be from the initial starting point to a point just beyond the 300-foot mark.

##### 4.3.3 Observer Responsibilities.

The flight test observer will be responsible for filling in the observer log during each maneuver. Start and stop times of each maneuver, pilot name, and date of each test will be recorded. In addition, the observer will make notes about equipment problems and local weather and wind conditions.

#### 4.3.4 Flight Systems Data.

The following airborne parameters, to be recorded at the Technical Center, will be reduced for analysis:

- a. Roll
- b. Pitch
- c. Aircraft heading

#### 4.3.5 Wind Information.

Ten wind sensors will be placed at various locations, from 1.0 to 2.5 rotor radii around the center of the helipad, to collect wind speed and direction information. This information will be examined to determine the rotorwash effect from an aircraft hovering and maneuvering at the surface.

#### 4.3.6 Barometric Pressure Information.

Five barometric pressure sensors will be placed at locations, varying from 1.5 to 2.5 rotor radii around the center of helipad, to collect pressure readings. These readings will be examined to determine the changes in pressure due to the rotorwash generated by a hovering or maneuvering aircraft.

### 5. DATA REDUCTION AND ANALYSIS.

#### 5.1 DATA TAPES.

All magnetic tapes obtained from the airborne data system will be time merged with the tapes from the ground tracker system. These data will be converted to engineering units. All merged data shall be examined and validated before final processing to assure the correct parameters were recorded and that the data are valid. Any outliers in the tracking tape will be removed. Linear interpolation will be used to correct any discontinuities in the airborne and tracker data. The output will be at a rate of one sample per second.

All wind and barometric pressure information from the hovering operations will be recorded to disk on a PC.

#### 5.2 DATA PROCESSING.

Ground tracker data from the taxiing operations will be translated using a rectangular coordinate reference system, which will be established with the origin at the starting point of the taxiing operations. The X and Y axis will run through the centerline with the X-axis positive on the approach side and negative behind the origin. The Y-axis will be perpendicular to the X-axis within the taxiway plane, positive to the right of the X-axis and negative to the left. The Z-axis is drawn perpendicular to the X-Y plane at the ground point of intercept (GPI), positive above and negative below the taxiway plane (figure 2).

The position of the aircraft in space as determined by the ground tracking system will be translated and rotated with respect to this rectangular coordinate system to within 5 feet. The processing will be performed on the VAX 11/750 minicomputer.

The information collected on disk from the hovers will be processed on the PC.



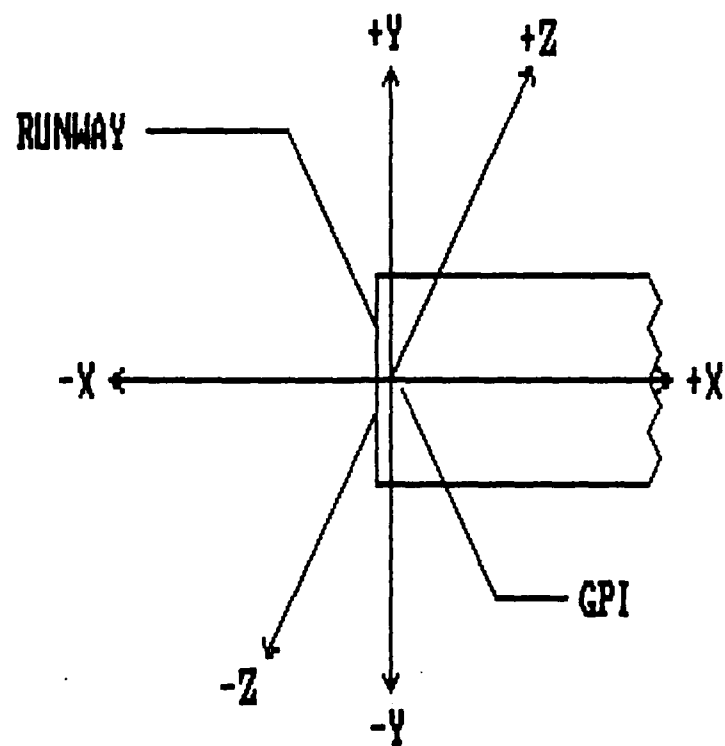


FIGURE 2. RECTANGULAR COORDINATE REFERENCE SYSTEM

### 5.3 GRAPHICAL PRESENTATION.

The following individual and composite plots will be generated on a Calcomp 1051 drum plotter using Calcomp 907 software for the VAX 11/750:

a. Profile view of each taxiing operation with intended path and criterion surface shown.

b. Probability plots, mean  $\pm 2$  standard deviation for each profile:

1. About the vertical track mean.
2. About the crosstrack mean.

c. Vertical and lateral aircraft position for each maneuver.

Plots will also be produced reflecting sensor readings vs. sensor distance. The means of the wind velocity and pressure data will be computed and plotted against the distance.

### 5.4 STATISTICAL ANALYSIS.

The following is a list of the parameters to be computed for vertical track deviation, crosstrack deviation, vertical track position, crosstrack position, wind velocity, and barometric pressure:

<u>Parameter</u>	<u>Notation</u>
Number of data points	N
Arithmetic mean	$\bar{X}$
Maximum value	Xmax
Minimum value	Xmin
Unbiased estimate of variance	$S_u^2$
Biased estimate of variance	$S_b^2$
Unbiased estimate of standard deviation	Su
Biased estimate of standard deviation	Sb
Skewness	$b_1$
Kurtosis	$b_2$

### 5.5 REPORTS.

The data will be analyzed and a final report will be written by Technical Center personnel. This report will contain all statistical data obtained from the taxiing and hover operations. The report will address the objectives of this test.

### 6. SCHEDULE.

Figure 3 describes the projected amount of time each phase of this project will need for completion. The following factors may have an impact on this schedule:

- a. Availability of the ground based tracker.
- b. Weather

# HELIPORT PARKING, TAXIING, LANDING AREAS PROJECT SCHEDULE

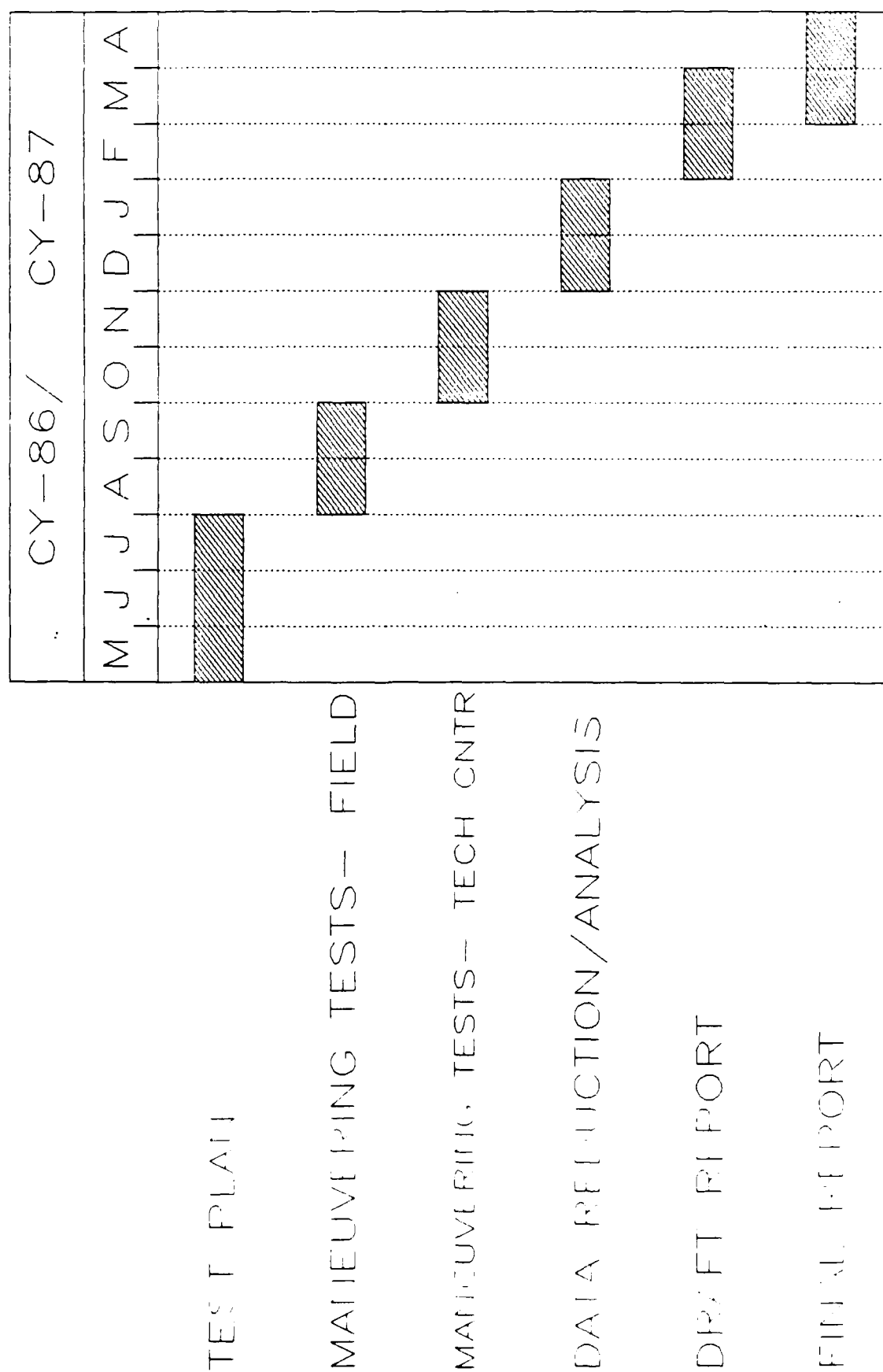


FIGURE 3. PROJECT SCHEDULE

- c. Accessibility of the computer facility for data reductions.
- d. Aircraft availability both at the Technical Center and in the field.
- e. Subject pilot availability at the Technical Center and at the operational heliports.

APPENDIX  
VMC DATA COLLECTION

LOCATION: INDIANAPOLIS/NEW YORK/OTHER

TIME:

DATE:

WIND CONDITIONS:

VISIBILITY:

TYPE AIRCRAFT:

GROSS WEIGHT:

KIND OF OPERATION:

\_\_\_ GROUND TAXI

\_\_\_ HOVER TAXI

\_\_\_ LANDING

\_\_\_ TAKEOFF

\_\_\_ PARKING

\_\_\_ HOVER IN

\_\_\_ GROUND TAXI IN

\_\_\_ TOW IN

HOVER HEIGHT:

LATERAL PLACEMENT:

ABLE TO TALK TO PILOT?: \_\_\_ YES \_\_\_ NO

IF YES:

PILOT FLIGHT TIME:

MINIMAL DISTANCE PILOT WOULD FEEL COMFORTABLE HOVERING/TAXIING

NEAR OBJECTS?

NEAR OTHER AIRCRAFT?

COMMENTS:

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